UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Note to Reader
September 9, 1998

Background: As part of its effort to involve the public in the implementation of the Food Quality Protection Act of 1996 (FQPA), which is designed to ensure that the United States continues to have the safest and most abundant food supply, EPA is undertaking an effort to open public dockets on the organophosphate pesticides. These dockets will make available to all interested parties documents that were developed as part of the U.S. Environmental Protection Agency's process for making reregistration eligibility decisions and tolerance reassessments consistent with FQPA. The dockets include preliminary health assessments and, where available, ecological risk assessments conducted by EPA, rebuttals or corrections to the risk assessments submitted by chemical registrants, and the Agency's response to the registrants' submissions.

The analyses contained in this docket are preliminary in nature and represent the information available to EPA at the time they were prepared. Additional information may have been submitted to EPA which has not yet been incorporated into these analyses, and registrants or others may be developing relevant information. It's common and appropriate that new information and analyses will be used to revise and refine the evaluations contained in these dockets to make them more comprehensive and realistic. The Agency cautions against premature conclusions based on these preliminary assessments and against any use of information contained in these documents out of their full context. Throughout this process, if unacceptable risks are identified, EPA will act to reduce or eliminate the risks.

There is a 60 day comment period in which the public and all interested parties are invited to submit comments on the information in this docket. Comments should directly relate to this organophosphate and to the information and issues

available in the information in this docket. Once the comment period closes, EPA will review all comments and revise the risk assessments, as necessary.

These preliminary risk assessments represent an early stage in the process by which EPA is evaluating the regulatory requirements applicable to existing pesticides. Through this opportunity for notice and comment, the Agency hopes to advance the openness and scientific soundness underpinning its decisions. This process is designed to assure that America continues to enjoy the safest and most abundant food supply. Through implementation of EPA's tolerance reassessment program under the Food Quality Protection Act, the food supply will become even safer. Leading health experts recommend that all people eat a wide variety of foods, including at least five servings of fruits and vegetables a day.

Note: This sheet is provided to help the reader understand how refined and developed the pesticide file is as of the date prepared, what if any changes have occurred recently, and what new information, if any, is expected to be included in the analysis before decisions are made. **It is not meant to be a summary of all current information regarding the chemical.** Rather, the sheet provides some context to better understand the substantive material in the docket (RED chapters, registrant rebuttals, Agency responses to rebuttals, etc.) for this pesticide.

Further, in some cases, differences may be noted between the RED chapters and the Agency's comprehensive reports on the hazard identification information and safety factors for all organophosphates. In these cases, information in the comprehensive reports is the most current and will, barring the submission of more data that the Agency finds useful, be used in the risk assessments.

Jack Housenger, Acting Director
Special Review and Reregistration
Division

August 19, 1994

MEMORANDUM

SUBJECT: Transmittal of EFED List A Summary Report for Fenamiphos (Chemical # 100601) Case # 0333

FROM: Janice King Jensen
Pesticide Management and Disposal Staff
Environmental Fate and Effects Division

THRU: Evert K. Byington, Chief
Science Analysis & Coordination Staff
Environmental Fate and Effects Division

TO: Esther Saito, Chief
Reregistration Branch
Special Review & Reregistration Division

Attached please find the following documents for the completed EFED summary report of Fenamiphos.

1. EFGWB Science Chapter
2. EEB Science Chapter
3. SACS Reregistration Summary Report

Fenamiphos exceeds acute high and chronic levels of concern for terrestrial, freshwater and marine organisms. In addition, fenamiphos exceeds levels of concern for ground and surface water. Data gaps were identified for this reregistration case. If you have any questions concerning this case, please contact Janice Jensen at 305-7706.

cc: (with SACS Reregistration Summary Report attached)

Anne Barton	Tony Maciorowski	Laura Dye
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List A File	List A Cover Memo File	Peter Caulkins

A. Environmental Assessment

1. Environmental Fate

At this time, three data requirements in the environmental fate guidelines are either not fulfilled or need to be upgraded for fenamiphos: the unaged portion of the leaching/adsorption/desorption (163-1), terrestrial field dissipation (164-1), and prospective ground water monitoring (166-1). However, EFED has sufficient data for comprehensive qualitative and quantitative environmental fate, ground and surface water assessments for fenamiphos.

a. Environmental Fate Assessment

Although the environmental fate data base is not complete, the information from acceptable and upgradeable environmental fate data from the 1987 Fenamiphos Registration Standard to present indicates that the major routes of dissipation for fenamiphos incorporated into the soil appear to be by microbial metabolism. The aerobic half-life was 15.7 days at 20^0C and the anaerobic half-life was 87.9 days at 20^0C, together with or followed by leaching of degradates and further degradation. The Freundlich K_{ad} values of fenamiphos ranged from 0.95 for sandy loam soil to 3.4 for silt loam soil, indicating that fenamiphos has the potential to be highly mobile to mobile in the soils tested. The degradates fenamiphos sulfoxide and fenamiphos sulfone appear to be more mobile than parent fenamiphos. In the field studies (Nemacur 3 EC) fenamiphos was not detected below the 0 to 6 inch soil horizon. Fenamiphos sulfoxide was detected as far as the 30 to 36 inch soil horizon in one study and fenamiphos sulfone was detected as far as the 18 to 24 inch soil horizon in the same study site. If fenamiphos were on the soil surface or in the water then photolysis appears to be rapid (aqueous photolysis half-life was between 2 to 4 hours under artificial light; soil photolysis half-life equals 2.7 hours under natural sunlight). Fenamiphos is relatively stable to hydrolysis (half-life equals 245 days at pH 5.0, 301 days at pH 7.0, and 235 days at pH 9.0).

b. Environmental Chemistry, Fate and Transport

(1) Hydrolysis

Based on acceptable hydrolysis data fenamiphos appears to be relatively stable to hydrolysis in buffer solutions with reported half-lives of 245 days at pH 5.0, 301 days at pH 7.0, and 235 days at pH 9.0. The major degradate reported was fenamiphos sulfoxide which by day 31 of the study accounted for 9.9 percent of the radioactivity in the pH 5.0 samples, 8.1 percent in the pH 7.0 samples, and 4.1 percent in the pH 9.0 samples. Fenamiphos phenol was found in the pH 9.0 samples (5.2

percent of the total radioactivity by day 31). (MRID # 42149302)

(2) Photodegradation in water

Based on acceptable aqueous photolysis data submitted previously, fenamiphos rapidly photodegrades in water. The aqueous photolysis half-life was between 2 and 4 hours at Ph 7.0 when exposed to artificial (450 watt mercury arc lamp emitting light of approximately 5200 uW/cm^2 intensity at the sample surface) between 300 and 600 nm. After 24 hours of irradiation fenamiphos accounted for approximately 4 percent of the applied radioactivity and the major degradates reported were fenamiphos sulfonic acid phenol (approximately 19 percent), fenamiphos sulfoxide (approximately 17 percent), and fenamiphos sulfonic acid (approximately 6 percent). (MRID # 40608001)

(3) Photodegradation in soil

Fenamiphos photodegrades in soil when exposed to natural sunlight. Based on acceptable soil photolysis data, the half-life of fenamiphos was 2.7 hours when exposed to natural sunlight. The radioactive components identified from the treated exposed soil samples were fenamiphos sulfoxide and parent fenamiphos. (MRID # 40608001)

(4) Aerobic soil metabolism

Fenamiphos metabolizes in soil under aerobic conditions. Based on acceptable aerobic soil metabolism data fenamiphos applied at a rate of 13.7 parts per million (ppm) to Howe sandy loam soil degraded rapidly (half-life equals 15.7 days) to form fenamiphos sulfoxide (maximum of 51.4 percent by day 14), fenamiphos sulfone (maximum of 3.5 percent at day 14), fenamiphos phenol (<0.1 percent at all sampling times), fenamiphos sulfoxide phenol (maximum of 5.4 percent on day 31), fenamiphos sulfone phenol (maximum of 24.3 percent on day 63), and fenamiphos sulfone anisole (maximum of 4.4 percent on day 365). By the end of the study 34.2 percent of the applied radioactivity was quantitated as radiolabeled carbon dioxide ($^{14}CO_2$). The proposed metabolic pathway indicated that fenamiphos transformed to the corresponding sulfoxide metabolite and further degraded to fenamiphos sulfoxide phenol and fenamiphos sulfone phenol. Carbon dioxide (CO_2) appeared to be produced from the degradation of fenamiphos sulfoxide phenol, fenamiphos sulfone phenol and possibly from the degradation of fenamiphos phenol. An additional

ancillary study indicated that fenamiphos degraded in the soil more rapidly at 22^0C than at 16^0C and also more rapidly at 28^0C than at 22^0C. (MRID #s 42149303, 41064302, 40933701 and 40524601)

(5) Anaerobic soil metabolism

Fenamiphos metabolizes in soil under anaerobic conditions. Based on acceptable anaerobic soil metabolism data fenamiphos, applied at a rate of 13.3 ppm to a Howe sandy loam soil, degraded with a half-life of 87.9 days. In this study fenamiphos was incubated for 6 days under aerobic conditions followed by 60 days incubation under anaerobic conditions. Fenamiphos declined from 36.3 percent on day 0 of anaerobic incubation (following the 6 day aerobic incubation) to 21.8 $\pm$ 1.9 percent after 60 days anaerobic incubation. The major metabolite was fenamiphos sulfoxide (maximum of 46.5 percent at day 6 of aerobic conditions and decreasing to 14.3 percent after 60 days anaerobic incubation). Other reported metabolites were fenamiphos sulfone (maximum of 0.5 percent on days 52 and 66), fenamiphos phenol (maximum of 3.2 percent on day 36), fenamiphos sulfone phenol (maximum of 8.7 percent on day 66), and fenamiphos sulfone anisole (<1 percent on day 66). (MRID #s 41286901, 40524601, and 40524601)

(6) Leaching and adsorption/desorption

Fenamiphos and its metabolites have the potential to be mobile in soil. Based on upgradeable batch equilibrium data the reported Freundlich K_{ad} values from four unclassified soils ranged from 0.95 in a sandy loam soil to 3.4 in a silt loam soil. The K_{oc} values ranged from 165.6 to 543.4. These values indicate that parent fenamiphos has the potential to be relatively mobile in the soils tested. Based on acceptable column leaching studies, parent fenamiphos was mobile (16.2 percent to 63.8 percent of applied radioactivity was found in the leachate). The major metabolites, fenamiphos sulfoxide and fenamiphos sulfone were more mobile. The greatest mobility of fenamiphos and its metabolites was in the soil with the lowest cation exchange capacity and the lowest percentage of organic matter (Indiana sand soil) and vice versa (Kansas sandy loam soil). No parent fenamiphos was found in the leachate from the Kansas sandy loam soil. The leachate from the soil columns contained 47.2 percent of applied radioactivity in the California sandy loam soil, 63.8 percent in the Indiana sand soil, and 16.2 percent in the Kansas sandy loam soil. Of this radioactivity found in the leachates the majority was fenamiphos sulfoxide (86.44 percent of radioactivity in leachate from the California sandy loam soil, 76.48 percent of

radioactivity in leachate from the Indiana and soil and 90.12 percent of radioactivity in the leachate from the Kansas sandy loam soil). These results indicated that fenamiphos sulfoxide was the most mobile metabolite, followed by fenamiphos sulfone, and the majority of parent fenamiphos did not leach through the soil columns. (MRID #s 40547502, 40547501, 40774808, and 40774807)

(7) Laboratory volatility

Fenamiphos does not volatilize rapidly. Based on acceptable laboratory volatilization data fenamiphos did not volatilize very rapidly when applied at a rate of 12 lb of active ingredient per acre (a.i/A) to a sandy loam soil. After 7 days less than 0.1 percent fenamiphos volatilized indicating that volatilization was not a major route of dissipation for fenamiphos applied to the soil. (MRID # 40774810)

(8) Terrestrial field dissipation

In the field studies fenamiphos was less mobile than its degradates. Based on upgradeable terrestrial field dissipation studies conducted in Chualar and Fresno, California on established turf plots previously used for crop production, parent fenamiphos (Nemacur 3 EC) applied at 10 lb a.i./A was not very mobile. The half-life of fenamiphos was 16.2 days at the Chualar site and 17 days at the Fresno site. Parent fenamiphos was not detected (detection limit of 0.01 ppm) below the 0 to 6 inch soil horizon at the Chualar site and as far as the 18 to 24 inch soil horizon at the Fresno site. Fenamiphos sulfoxide was detected as far as the 24 to 30 inch soil horizon at the Chualar site and as far as the 30 to 36 inch soil horizon at the Fresno site. These studies confirmed the results of the laboratory leaching and adsorption/desorption studies demonstrating that the metabolites fenamiphos sulfoxide and fenamiphos sulfone are both more mobile than the parent and have a greater potential to leach in the soil. It appears that fenamiphos dissipates in the soil by microbial degradation to fenamiphos sulfoxide and fenamiphos sulfone followed by leaching into the soil and eventual further degradation as proposed in the aerobic soil metabolism study. (MRID #s 42149301 and 42216201)

At the Chualar site the concentration reported for total fenamiphos residues at day 0 of the first application at a rate of 10 lb a.i./A was 0.32 ppm (parent fenamiphos accounted for 0.21 ppm). The maximum concentration reported at this site for fenamiphos sulfoxide was 0.98 ppm at day 28 posttreatment and the maximum fenamiphos sulfone concentration was 0.32 also at day 28. At the Fresno site the

total residue concentration at day 0 was 4.06 ppm (parent fenamiphos was 2.668 ppm and fenamiphos sulfoxide was 1.39 ppm) and this was when the maximum concentration of parent fenamiphos and fenamiphos sulfoxide were reported. The maximum concentration of fenamiphos sulfone was 0.52 ppm at day 60 posttreatment. No information from acceptable field dissipation studies using granular (Nemacur 15 percent G) formulations is currently available. (MRID #s 42149303, Appendix 18).

Leaching of fenamiphos was confirmed by detections in ground water in Florida during a small-scale retrospective monitoring study. Concentrations of parent fenamiphos in ground water ranged up to 22.5 ppb or approximately 1100 percent of the lifetime Health Advisory. The sulfoxide and sulfone degradate concentrations ranged up to 204 ppb and 19.9 ppb respectively. For this reason, the Agency required that the registrant conduct a prospective ground-water monitoring study in 1992. The Agency also requested a label advisory at that time. (DP Barcode D157194)

(9) Fish bioaccumulation

Fenamiphos does not bioaccumulate in fish. Based on an acceptable fish bioaccumulation study, the maximum bioaccumulation factors (BCF) for fenamiphos residues were 89 BCFs for whole fish at 14 days exposure, 24 BCFs for fillet tissue at 7 days exposure, and 230 BCFs for viscera at 7 days exposure. The average steady state BCF was 86 during the course of the study. After 28 days the BCFs were 21, 61, and 98 for fillet, whole fish, and viscera, respectively. During the 14 day depuration period, accumulated ^{14}C-fenamiphos residues dropped >95 percent to 98 percent of the observed concentration at day 28 of uptake exposure in the fillet, whole fish and viscera, respectively. The phenol sulfone metabolite was the primary metabolite found in the tissue and accounted for 42.7 percent and 51.0 percent of the radioactivity in the 21 and 28 day viscera tissues. Parent fenamiphos, the sulfoxide, sulfone, phenol, and phenol sulfoxide metabolites were found in amounts less than 10 percent. These results indicated that fenamiphos did not bioaccumulate in fish and any residues taken up by fish were depurated when fish were no longer exposed to these residues. (MRID #s 40274201, 40274202, and 40274203)

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2. Ecological Effects

a. Ecological Effects Assessment

(1) Risk to Terrestrial Animals

Nontarget insects will be exposed to fenamiphos based on the end-use products's terrestrial food and nonfood use patterns. For nontarget insects, the honey bee (or *Apis mellifera)* is the representative test species. With an acute contact LD_{50} value of 1.87 micrograms per bee, fenamiphos is highly toxic to honey bees.

Avian and mammalian species will be exposed to fenamiphos through the consumption of insect and plant food material containing fenamiphos residues. The criterion for the determination of hazard and presumption of unacceptable risk from acute exposure for birds and mammals is a value greater than or equal to 0.5. This value, known as the risk quotient (RQ), is calculated by dividing the preliminary estimated environmental concentration (EEC) by the lowest LD_{50} value for birds and mammals.

Acute and Dietary RQ = EEC/LD_{50} or EEC/LC_{50} = 0.5 for birds and mammals

(a) Avian Acute and Subacute Dietary Effects

Fenamiphos is very highly toxic to birds, as indicated by tests conducted on the representative test species, the bobwhite quail. Acute LD_{50} and LC_{50} values are 1.6 mg/kg and 38 ppm, respectively.

Risk quotients can be calculated for granular and flowable formulations using the above formula. Due to the vast number of application strategies, many exposure scenarios (EECs) result in a multitude of risk quotients. In addition, for granular formulations, the acute oral LD_{50} is used to assess acute risk because the route of dosing in the study most closely correlates with the route of exposure for birds in the field (i.e., a bird receiving "doses" of the pesticide in the form of granules). Whereas, the avian dietary LC_{50} is used to assess acute risk from flowable formulations because the route of exposure for test birds in the laboratory studies most closely corresponds to the route of exposure in the field (i.e., laboratory ingestion of fenamiphos-

contaminated food items by the representative test species most closely simulates birds ingesting fenamiphos-contaminated food items after broadcast spraying the field).

Emulsifiable Formulations. Results of simulated and actual field studies suggest that applications of the emulsifiable concentrate, Nemacur 3, can cause mortality to avian species. In order to estimate the degree of risk, EFED developed acute risk quotients based on the maximum and minimum EEC and the lowest LC_{50} values for avian species. The table below indicates the maximum and minimum acute mortality risk quotients resulting from the application of Nemacur 3 for all currently registered use sites. These risk quotients represent the ratio between the maximum and minimum EEC, as derived from the Kenaga nomograph, and the lowest LC_{50} value available for fenamiphos (i.e, 38 ppm for the bobwhite quail). Whenever this ratio is greater than 0.5, the Agency's acute level of concern (LOC) has been exceeded.

Maximum and Minimum Dietary Risk Quotients for Nemacur 3

Crop	Pest[1]	Appl Method	Lbs. ai/ Treated	Unincor[2]-porated	Lbs ai/A Exposed	Maximum EEC(ppm)	Max Risk Quotient	Min Risk Quotient	Minimum EEC(ppm)

Apple	N	Banded	20	1	20	4800	126.3	3.7
140							126.3	3.7
Cherry	N	Banded	20	1	20	4800	126.3	3.7
140							126.3	3.7
Peach	N	Banded	20	1	20	4800	126.3	3.7
140							113.7	3.3
Nectarine	N	Banded	20	1	20	4800	113.7	3.3
140							75.8	2.2
Citrus	N	Banded	20	1	20	4800	8.5	0.2
140							8.5	0.2
Grapes	N	Banded	18	1	18	4320	8.5	0.2
126							8.5	0.2
Non-Bear	N	Banded	18	1	18	4320	8.5	0.2
126							8.5	0.2
Raspberry	N	Banded	12	1	12	2880	5.7	0.2
84							5.7	0.2
Apple	N	Low Pressure	9	0.15	1.35	324	25.3	0.7
9.45							25.3	0.7
Cherry	N	Low Pressure	9	0.15	1.35	324	25.3	0.7
9.45							34.4	1.0
Peach	N	Low Pressure	9	0.15	1.35	324	34.4	1.0
9.45							19.9	0.6
Nectarine	N	Low Pressure	9	0.15	1.35	324	198.6	5.8
9.45							57.8	1.7
Grapes	N	Low Pressure	9	0.15	1.35	324	427.3	12.5
9.45							35.7	1.0
Citrus	N	Low Pressure	9	0.15	1.35	324	39.3	1.1
9.45							57.8	1.7
Non-Bear	N	Low Pressure	6	0.15	0.9	216	35.5	1.0
6.3							1.6	0.0
Kiwi	N	Low Pressure	6	0.15	0.9	216	44.8	1.3
6.3							37.9	1.1
Asparagus	N	Nursery	4	1	4	960	4.7	0.1
28								
	N	Field	4	1	4	960	126.3	3.7
28							18.9	0.6
	N	P.Harvest	4	1	4	960	37.9	1.1
28							63.2	1.8
Eggplant	N	Banded	5.4	1	5.44		35.5	1.0
1305.6	38.08	Beets	N	Banded	5.4	1	63.2	1.8
5.44	1305.6	38.08	Cotton	T	Banded	3.1		
1	3.14	755	22.01					
	T	In-Furrow	31.4	1	31.44	7547		
220								
	T,N	Banded	9.1	1	9.15	2195		
64								
	T,N	In-Furrow	67.7	1	67.65	16237		
474								
	T,N	Banded	5.7	1	5.65	1357		
40								
(Calif)	T,N	Banded si	6.2	1	6.23	1494		
44								
	T,N	Banded	9.1	1	9.15	2195		
64								
	T,N	Banded	5.6	1	5.62	1349		
39								
Cabbage-FL	N	Drench	1.7	0.15	0.26	62		
2								
Peanuts	T,N	Banded	7.1	1	7.10	1704		
50								
Tobacco	T,A	Brdcst	6	1	6.0	1440		
42								
Bananas	N	Low Pressure	5	0.15	0.75	180		
5								
Pineapple								
preplant-HI	N	Brdcst	20	1	20.0	4800		
140								
preplant-HI	N	Drip	20	0.15	3	720		

[1] N=Nematodes; T=Thrips; A= Aphids; MC=Mole Crickets [2] 1 = 100% exposure; 0.15 = 85% incorporated

The maximum acute avian risk quotients ranged from a low of 1.6, for a 5 fl.oz. per 1,000 row ft. drench application on cabbage, to 427.3, for a 7.1 oz/1000 ft of row in-furrow application on cotton. The minimum acute risk quotients ranged from 0.05, for the drench use on cabbage, to a high of 12.5 for in-furrow application on cotton. All use patterns result in maximum acute risk quotients that are above the LOC. Low pressure applications on apples, cherries, peaches, nectarines, grapes, citrus, nonbearing fruit trees, kiwis, and bananas, as well as the drench application on cabbage, resulted in minimum risk quotients that were below the LOC.

Based on these data, adverse ecological effects to avian species are expected to occur on all use sites.

Field Study Conducted on Tobacco. A multi-year field study was conducted on tobacco in Martin County, North Carolina (MRID #s, 42029904 and 42029903). Fenamiphos, formulated as Nemacur 3, was applied with ground equipment at an application rate of 6 lbs a.i./A followed by soil incorporation. Based on maximum and minimum EECs, risk quotients for the tobacco use pattern should range from 1.1 to 37.9 (see the table above). These calculations suggest that mortality and other ecological effects may have occurred at levels significantly greater than that observed for the study.

But the study documented a only a total of 73 mortalities which include birds, mammals and other vertebrates. Twelve of the 73 documented mortalities were found on treated plots post-application. The casualty search data suggest that treatment did not result in any appreciable mortality when compared to controls. However, the carcass search techniques and the number of replicates used in conducting the study did not satisfy the requirements for the binomial theorem, as set forth by Fite et. al.(1988). Therefore, the EFED concludes that the results of the two year study do not rebut the Agency's presumption that the use of Nemacur 3 on tobacco will exceed the high risk LOC of 0.5.

Field Study Conducted on a Golf Course. Fenamiphos, formulated as Nemacur 3 and applied with ground equipment at a rate of 10 lbs a.i./A, resulted in treatment-related mortality to avian species when applied to golf courses (MRID # 42029901). In addition to mortality, behaviorally-impaired birds were also observed. Eighty-nine percent of the treatment-related deaths and behavioral impairments were found on the day of application or the next day, and only one occurred later than day 2 post-treatment. Residue levels in dead or dying invertebrates averaged 96.27 ppm on treatment day, and birds were observed actively foraging on these items. Beyond day 2, invertebrate residues had dropped to less than 3 ppm and the presence of dead or dying invertebrates on the turf surface was greatly reduced.

Several species of birds were observed feeding on mole crickets (primary pest species) prior to and following application. Species feeding on mole crickets included common grackles (Quiscalus quiscula), boat-tailed grackles (Quiscalus major), European starlings (Sturnus vulgaris), northern mockingbirds (Mimus polyglottos), blue jays (Cyanocitta cristata), red-winged blackbirds (Agelaius phoeniceus) fish crows (Corvus ossifragus) common ground doves (Columbina passerina) and common nighthawks (Chordeiles minor).

In general, results from Nemacur 3 field studies indicate that (1) exposure occurred to numerous nontarget avian species, (2) residues appeared in all the matrices sampled and (3) residues, at least for some matrices, exceed the reference LC_{50} value of 38 ppm. In addition, results show that Nemacur 3, even when applied according to label directions, has an effect on numerous nontarget terrestrial wildlife.

Field Incidents. EFED has only one record of a field incident involving avian mortality from the use of Nemacur 3. The incident involved approximately 58 birds (robins and cedar waxwings) and occurred on a golf course in Martin county, Florida (MRID # 1000103). Acetylcholinesterase (AChE) levels were determined for brain tissue and were found to be within normal ranges for the species. Residue analysis of the crop, ventriculus and contents of these birds showed Nemacur levels ranging from 15.4 ppm to 2090 ppm. No significant histopathologic abnormalities were noted. The report stated that the esophagus and proventriculus of the birds were full of Brazilian Pepper Tree (Schinus terebinthefolius) seeds. The report could not explain why the AChE levels were within normal range for the birds.

Granulated Formulations. The primary route of exposure to avian species is expected to be from the ingestion of granules as food and/or grit and drinking contaminated water. The number of granules which are equivalent to the LD_{50} value of 1.6 mg/kg for the bobwhite quail can be determined using the following: the body weight of each species of bird (as represented in the table below); the average weight of a 15G granule, which is O.O87 mg (Balcomb et al., 1984); and the amount by weight of active ingredient present in the granular formulation.

According to E. Hill of the Patuxent Wildlife Research Center, 16.0 mg/kg is the amount of active ingredient present in a 15G formulation of fenamiphos. The average weight for the bobwhite quail is .2 kg. The bobwhite must consume 3.2 mg or 37 granules to reach the equivalent of the LD_{50} value of 1.6 mg/kg.

LD_{50} /bird in mg = 16 mg/kg a.i. X .2 kg/bobwhite = 3.2

Number of granules/bobwhite = 3.2 mg/bird/0.087 mg/granule = 37

The table below indicates the calculations for six avian species likely to be exposed to both the 10G and 15G formulations. The table below indicates the number of granules each species must ingest to reach the acute LD_{50} value of 1.6 mg/kg.

Number of 10 and 15G Granules Equivalent to the LD50 for Six Avian Species

Species	Body Weight (G)	LD_{50} Mg/Animal	No. 15G Granules	No. 10G Granules
Bobwhite	200	3.2	37	55
Robin	80	1.2	13.8	22
Mourning Dove	100	1.6	18.5	27.5
House Sparrow	20	0.32	3.7	5.5
Redwing Blackbird	50	0.80	9.0	14.0
Grasshopper Sparrow	14	0.22	2.5	3.8

Balcomb et al., (1984) found that 40 and 60 percent mortality occurred in red-winged blackbirds when dosed with 5 and 10 granules of Nemacur 10G, respectively. These results compare with the estimates presented in the table above and suggest that there is little margin for safety, especially for small birds that forage for food or grit on the soil surface, from the application of granulated formulations of fenamiphos.

In addition, risk quotients for the various uses of fenamiphos were determined by comparing the EEC, expressed as mg a.i./sq. ft, with the LD_{50} value and the mean weight for the bobwhite quail. Each calculated EEC in the table below represents in milligrams the amount of active ingredient per square foot of treated area that is likely to occur from the use of the granulated formulations. EECs were determined by converting application rates, typically expressed as the number of ounces of product applied per 1,000 feet of linear row, into application rates for a treated acre, by adjusting for band and row widths. The numerical value was then adjusted to account for the various soil incorporation methods allowed by the label.

RQ = Exposure in mg a.i./sq. ft. / (Bird wt. in kg.)(Quail LD50 in mg/kg)

RQ = Exposure / (0.178 kg)(1.6 mg/kg)

Avian risk quotients range from a low of 4, for a broadcast use on bananas, to a high of 190 for a banded application on flower bulbs. As demonstrated in the table below, all of the use sites exceed the high risk LOC (0.5) for avian species and indicate that total exposure (i.e., all routes of exposure including dermal, oral

and inhalation) will result in high risk to avian species.

Avian Risk Quotients for Granulated Formulations of Fenamiphos

Crop	Exposure (a.i./sq. ft.)	Avian Risk Quotient (LD_{50}/sq. ft.)
Cotton	2.7-5.1	8-18
Peanuts	11.9	42
Bananas	1.2	4
Bok Choy	9.4	33
Brussel Sprouts	9.4	33
Cabbage	9.4	33
Eggplant	9.4	33
Garlic	7.8	27
Okra	9.4	33
Peppers	9.4	33
Strawberry	9.4-10.8	33-38
Citrus	31.5	111
Pineapple	31.5	111
Turfgrass	15.6	55
Ornamentals:		
L.Leaf Fern	15.6	55
Protea	15.2	53
Anthurium	15.6	55
Nursery Stock	15.6	55
Bulbs	54.0	190

EEB has reviewed two field studies involving granulated formulations of fenamiphos. One study was conducted on various golf courses located near Orlando, Florida (MRID # 41012902) while the other study was conducted in citrus, near Titusville, Florida (MRID # 42029902).

Field Study Conducted on a Golf Course. As part of a baseline study, Nemacur 10G was applied at recommended label rates to several golf courses in central Florida. Several instances of bird mortality and/or behavioral effects were documented. Twenty seven of the 158 observed birds showed symptoms of toxicological poisoning, with 13 birds dying. Affected species included fish crows, starlings, mockingbirds, boat-tailed grackles, blue jay, brown thrasher (Toxostoma rufum), and loggerhead shrike (Lanius ludovicianus). In addition to mortality the following behaviors were noted: opening and closing of bill, loss of balance, outstretched wings, tucking the head inward, limping, and salivating. Again several species were observed feeding on mole crickets prior to and following application. In addition to the mortalities documented in this study, golf course personnel indicated they often notice that cattle egrets (Bulbucus ibis) are also killed from Nemacur 10G applications.

Field Study Conducted in Six Citrus Groves. A citrus field study where fenamiphos, formulated as Nemacur 15G, was applied with ground equipment at

an application rate of 20 lbs a.i./acre, was conducted on six groves located near Titusville, Florida (MRID # 42029902). After application, a spiked drag was used to soil incorporate the exposed granules. A total of 93 species of birds were recorded on and around the groves during the study. Based on results obtained from analysis of plasma cholinesterase (ChE) for the northern cardinal, approximately one third of the birds present on the treated groves were exposed to Nemacur 15G. However, ChE levels recovered to near control levels by 30 days post-treatment. The mean residue value for soils collected immediately post-application was 29.41 ppm. Nemacur 15G residues in soil were found to have an overall half-life of approximately 8.2 days. The mean residue value for vegetation collected post-application was 0.72 ppm with a half-life of 10.9 days.

In general, results of the Nemacur 10 and 15G field studies show that (1) exposure occurred to numerous nontarget avian species, and (2) mortality as well as other toxicological symptoms occurred (i.e., behavioral effects and ChE depression), even when fenamiphos is applied according to label directions.

(b) Avian Chronic Effects

Fenamiphos is expected to adversely affect avian reproduction under normal conditions of use. The LOC for chronic exposure is based on the lowest no-effect level (NOEL) as determined from avian laboratory reproductive studies. The lowest NOEL for fenamiphos is 2 ppm for the bobwhite quail (MRID # 00121291). The following table indicates the maximum and minimum chronic risk quotients based on the NOEL for the bobwhite quail.

Maximum and Minimum Chronic Risk Quotients for Nemacur 3, Emulsifiable Concentrate Formulation

Crop	Pest[1]	Appl Method	Lbs. ai/ Treated	Maximum EEC (ppm)	Max Risk Quotient	Min Risk Quotient
Minimum EEC (ppm)						

Apple	N	Banded	20	4800		2400	70
140						2400	70
Cherry	N	Banded	20	4800		2400	70
140						2400	70
Peach	N	Banded	20	4800		2400	70
140						2160	63
Nectarine	N	Banded	20	4800		2160	63
140						1440	42
Citrus	N	Banded	20	4800		162	5
140						162	5
Grapes	N	Banded	18	4320		162	5
126						162	5
Non-Bear	N	Banded	18	4320		162	5
126						162	5
Raspberry	N	Banded	12	2880		108	3
84						108	3
Apple	N	Low Press.	9	324		480	14
9.45						480	14
Cherry	N	Low Press.	9	324		480	14
9.45						653	19
Peach	N	Low Press.	9	324		653	19
9.45						377	11
Nectarine	N	Low Press.	9	324		3773	110
9.45						1098	32
Grapes	N	Low Press.	9	324		8118	237
9.45						678	20
Citrus	N	Low Press.	9	324		747	22
9.45						1098	32
Non-Bear	N	Low Press.	6	216		674	20
6.3						31	1
Kiwi	N	Low Press.	6	216		852	25
6.3						720	21
Asparagus	N	Nursery	4	960		90	3
28							
	N	Field	4	960		2400	70
28						360	11
	N	P.Harvest	4	960		720	21
28						1200	35
Eggplant	N	Banded	5.4	1305		674	20
38.08						1200	35
Beets	N	Banded	5.4	1305			
38.08							
Cotton	T	Banded	3.1	755			
22.01							
	T	In-Furrow	31.4	7547			
220							
	T,N	Banded	9.1	2195			
64							
	T,N	In-Furrow	67.7	16237			
474							
	T,N	Banded	5.7	1357			
40							
(Calif)	T,N	Banded (si)	6.2	1494			
44							
	T,N	Banded	9.1	2195			
64							
	T,N	Banded	5.6	1349			
39							
Cabbage-FL	N	Drench	1.7	62	2		
Peanuts	T,N	Banded	7.1	1704			
50							
Tobacco	T,A	Brdcst	6	1440			
42							
Bananas	N	Low Press.	5	180	5		
Pineapple							
preplant-HI	N	Brdcst	20	4800			
140							
preplant-HI	N	Drip	20	720			

[1] N= Nematodes, T= Thrips, A= Aphids, and MC= Mole Crickets

Maximum chronic risk quotients ranged from 31, for a 5 fl.oz. per 1,000 row ft. drench application on cabbage, to 8118, for a 7.1 oz/1000 ft of row, in-furrow application on cotton. Maximum chronic risk quotients exceeded the NOEL for all use sites. Minimum chronic risk quotients ranged from 1, for the drench application on cabbage, to 236 for the in-furrow application on cotton. Minimum chronic risk quotients exceeded the NOEL for all use sites.

Based on these calculations, avian reproductive effects are expected to occur on all use sites. However, there are no field incidents and/or other field information available that indicate Nemacur 3 actually causes reproductive impairment to avian species when used according to label directions.

In addition, laboratory studies have shown that the sulfoxide metabolite is more toxic that the parent material. Environmental fate data show that fenamiphos and its' major metabolites are translocated systemically to plants and that the sulfoxide may be present in certain soils up to two years after application.

Lastly, based upon the available toxicity data and EECs, including the results of field studies and field incidents, the EEB concludes that the use of fenamiphos, both as an emulsifiable concentrate and/or granular formulation, exceed high risk LOCs for terrestrial wildlife.

(c) Mammalian Effects

Mammals appear to be as sensitive to fenamiphos as birds. Even though its toxicity value is somewhat higher than the bird toxicity value, fenamiphos is also classified as very highly toxic to mammals based on acute oral toxicity studies. Testing of the technical grade material resulted in a LD_{50} value of 2.38 mg/kg for the laboratory rat. Moreover, a rat second generation reproduction study indicated a NOEL of 40 ppm.

Mammals will be exposed to fenamiphos flowable formulations through the consumption of insect and plant food material containing fenamiphos residues. In addition, granular products also represent a potential hazard to mammals. With the exception of grit, mammals have the same potential sources of exposure to granules as birds. Granules may be ingested directly while foraging for seeds or insects at or below the soil surface on treated areas. Mammals may also ingest granules adhered to the surface of invertebrate prey items. Some exposure may occur through dermal absorption form either contact with surface granules of contaminated soil.

Incidents. As noted above in the avian section, significant avian and mammalian mortality occurred for five days following an application of Nemacur 3 sprayed at a rate of 6 lbs a.i./A. The study documented only a total of 73 mortalities which include birds, mammals and other vertebrates. Twelve of the 73 documented mortalities were found on treated plots post-application.

(2) Risk to Aquatic Organisms

Fenamiphos is very highly toxic to freshwater and marine species of fish, to freshwater invertebrates like *Daphnia magna*, and estuarine and marine organisms like the Eastern oyster.

Characterizing risk to aquatic species is a function of the ecotoxicological hazard and environmental exposure. It is performed in a manner similar to that for birds. The exception is that the EECs are calculated differently. EFED calculates "risk quotients" (EEC/LC_{50} or LD_{50} of the most sensitive species), and then compares these to regulatory levels of concern (LOCs). LOCs for aquatic species are: 0.5 for acute high risk; 0.1 for acute restricted use; 0.05 for acute endangered species; and 1.0 for chronic risk. When the risk quotient exceeds the LOC for a particular category, then risk to that category is presumed to exist.

The greatest potential exposure for hazard to non-target fish and aquatic invertebrates would occur if fenamiphos was applied directly to water. This could happen if fenamiphos was aerially applied as a broadcast treatment. However, a review of all the labels shows that there are no use sites that allow for aerial application of either the emulsifiable or granulated products of fenamiphos. Therefore, EFED does not believe that any direct contamination to aquatic environments is likely to occur from the use of fenamiphos.

Label directions limit application to either ground equipment, low pressure irrigation, or chemigation methods. Considering these methods, contamination to aquatic environments from drift is unlikely. Therefore, EFED believes that the major route of exposure to aquatic environments is from runoff.

EECs for fenamiphos from runoff have been calculated for both pond and stream aquatic environments using the EXAMS II model (Exposure Analysis Modeling System, 1987). The Georgia pond-stream model consists of a one hectare farm pond, 2 meters deep, that is surrounded by a 10 hectare basin that drains into two streams. The short stream is 100 meters long, 3 meters wide and 0.5 meters deep, while the long stream is 300 meters long, 3 meters wide and .05 meters deep.

The EECs were calculated using the amount of runoff from a 10 hectare tobacco field into a Georgia farm pond, draining into a short and long stream. It is assumed fenamiphos is applied at 20 lbs a.i./A, the maximum label rate. Calculations are based on two different application methods: soil incorporation (2 inches to 4 inches) immediately following application, and "watering-in."

EECs in ppb of fenamiphos for the pond-stream scenarios from runoff are included in the table below.

Fenamiphos EECs for Pond-Stream Scenarios: Application Method and Runoff Event

Application Method	Pond (EECs in ppb)	Short Stream (EECs in ppb)	Long Stream (EECs in ppb)
Soil incorp, 2-4"			
1% runoff	14.55	10.45	7.25
5% runoff	72.8	52.27	36.25
Watered-in			
1% runoff	112	80.4	56
5% runoff	560	402	279

Using this pond exposure model, EFED has computed pond EECs based on different soil incorporation practices as described on the Nemacur labels. EECs likely to occur in a one hectare pond are expected to range from 14.55 to 72.8 ppb, for 1 and 5 percent runoff events, respectively. The EECs likely to occur to the same pond from a "watering-in" incorporation and 1 and 5 percent runoff events are 112 and 560 ppb, respectively.

Using the bluegill sunfish LC_{50} value of 9.6 ppb, the risk quotients for these different scenarios are presented in the table below.

Fenamiphos Pond Runoff Scenario: Use Site, Application Method and Rate, Runoff Event, and Risk Quotient (Bluegill sunfish LC_{50}=9.6 ppb)

Use Site	Application Rate	Runoff Event (EEC ppb)	Risk Quotient (EEC/LC50)
Tobacco field (soil incorporation)	20 lbs ai	1%= 14.55 ppb	1.5
		5%= 72 ppb	7.5
Tobacco field (watering-in)	20 lbs ai	1%= 112 ppb	11.6
		5%= 560 ppb	58.3

Using the above pond runoff scenario, risk quotients for four species of aquatic organisms can be calculated. These calculations are based on using the low (14.55 ppb) and high (560 ppb) EECs values from the above table, and using the same assumptions about use site (tobacco), application rate (20 lbs a.i./A) and runoff events. These risk quotients are summarized below:

Fenamiphos Aquatic Species Risk Quotients for Pond Runoff Scenario: Tobacco Use Site, High and Low Runoff Events, and Risk Quotient

Aquatic Species	LC50	Runoff Event (EEC ppb)	Risk Quotient (EEC/LC50)
Bluegill sunfish	9.6 ppb	14.55 ppb	1.5
		560 ppb	58.3
Rainbow trout	68 ppb	14.55 ppb	0.2
		560 ppb	8.2
Sheepshead minnow	17 ppb	14.55 ppb	0.9
		560 ppb	32.9
Daphnia magna	1.9 ppb	14.55 ppb	7.6
		560 ppb	294.7

These pond data suggest that even though soil incorporation or "watering-in" can reduce exposure, levels of fenamiphos likely to get into ponds and lakes from runoff still exceed the high risk LOC (0.5) for aquatic organisms.

From the table entitled "Fenamiphos EECs for Pond-Stream Scenarios," EECs for the short stream range from 10.45 to 52.27 ppb when applied by soil incorporation, and from 80.4 to 402 ppb when "watered-in". EECs for the long stream range from 7.25 to 36.25 ppb when soil incorporated, and from 56 to 279 ppb when "watered-in".

Using the bluegill sunfish LC_{50} value of 9.6 ppb, the risk quotients for these different stream scenarios are presented in the table below.

Fenamiphos Stream Runoff Scenario: Use Site, Application Method and Rate, Runoff Event, and Risk Quotient (Bluegill sunfish LC_{50} = 9.6 ppb)

Use Site	Application Rate	Runoff Event (EEC ppb)	Risk Quotient (EEC/LC50)
Tobacco field (soil incorporated to 2-4" range)	20 lbs ai	1% Event 10.45 ppb short stream 7.25 ppb long stream	 1.1 0.8
		5% Event 52.27 ppb short stream 36.25 ppb long stream	 5.4 3.8
Tobacco field (watering-in)	20 lbs ai	1% Event 80 ppb short stream 56 ppb long stream	 8.3 5.8
		5% Event 420 ppb short stream 279 ppb long stream	 43.5 29.1

Using the above stream runoff scenario, risk quotients for four species of aquatic organisms can be calculated. These calculations are based on using the low (7.25 ppb) and high (420 ppb) EECs values from the table entitled "Fenamiphos EECs for Pond-Stream Scenarios" and the same assumptions about use site (tobacco), application rate (20 lbs a.i./A) and runoff events. These risk quotients are summarized below:

Fenamiphos Aquatic Species Risk Quotients for Stream Runoff Scenario: Tobacco Use Site, High and Low Runoff Events, and Risk Quotient

Aquatic Species	LC50	Runoff Event (EEC ppb)	Risk Quotient (EEC/LC50)
Bluegill sunfish	9.6 ppb	7.25 ppb	0.8
		420 ppb	43.5
Rainbow trout	68 ppb	7.25 ppb	0.1
		420 ppb	6.1
Sheepshead minnow	17 ppb	7.25 ppb	0.4
		420 ppb	24.7
Daphnia magna	1.9 ppb	7.25 ppb	3.8
		420 ppb	221

Again, these data suggest that levels of fenamiphos and its metabolites, likely to get into streams and small rivers, exceed the high risk LOC (0.5) for aquatic organisms.

Field studies have been conducted to evaluate fenamiphos toxicity on aquatic organisms. An experimental pond study, called a mesocosm study, was conducted to determine the potential effects of fenamiphos on fish and other aquatic organisms. Because potential field exposures exceed the results derived from laboratory toxicity studies, dosing levels for the study were not based on EECs. Instead, the mesocosms were dosed at 12.5, 3.5 and 1.0 ppb.

Treatment at 12.5 ppb caused a reduction in number and richness of zooplankton for several weeks post treatment. Zooplankton groups affected most were rotifiers, where populations decreased, and copepoda, where populations increased. Macro-invertebrate populations were also affected. There was a reduction in species richness at 3.5 and 12.5 ppb treatment when compared to controls. In addition a number of secondary effects, such as enhanced populations, related to reduced predation pressures were produced as a result of the acute effects of Nemacur on fish. No acute effects were observed on adult fish at the 1.0 and 3.5 levels. Acute effects were observed at both the 12.5 ppb level in both adult and young fish within 24 hours after application. Based on these results, a no-significant-adverse-effects concentration for this study would be the nominal test concentration of 3.5 ppb.

EFED has records of 5 fish kills from the use of fenamiphos. All of these kills occurred from the golf course use pattern and were observed after heavy rainfall occurred shortly after treatment, usually within 2 days of application.

In summary, based on laboratory toxicity data, EECs, models, a mesocosm study, and actual field incidents, EFED concludes that the use of fenamiphos, both as an emulsifiable concentrate and granulated formulation, exceeds the high risk LOC (0.5) for freshwater as well as marine and estuarine aquatic organisms.

(3) Risk to Terrestrial, Semi-Aquatic and Aquatic Plants

Unless there are known reports of phytotoxicity resulting from the use of a specific insecticide/nematicide, terrestrial and aquatic plant testing are not required; at this time, there are no known incidents of adverse effects to plants resulting from fenamiphos use that have been reported to the Agency.

(4) Risk to Endangered Species

For endangered avian and mammalian species the risk quotient is a value greater than or equal to 0.1. For endangered aquatic vertebrate and invertebrate species, the risk quotient is 0.05.

$RQ = EEC/LC_{50}$ > or = 0.1 for endangered birds and mammals

$RQ = EEC/LC_{50}$ > or = 0.05 for endangered aquatic animals

$RQ = EEC/EC_{25}$ and the EEC/EC_{50} > or = 1 for terrestrial, semi-aquatic & aquatic plants.

In the U.S. Fish and Wildlife Service Biological Opinion on Selected Pesticides dated June 14, 1989, forty five species of aquatic organisms and four terrestrial species of animals are considered endangered for use sites where cotton and soybeans are grown. This list is included at the end of this chapter.

The Endangered Species Protection Program is expected to become final in 1994. Limitations in the use of fenamiphos will be required to protect endangered and threatened species, but these limitations have not been defined and may be formulation specific. EPA anticipates that a consultation with the Fish and Wildlife Service will be conducted in accordance with the species-based priority approach described in the Program. After completion of the consultation, registrants will be informed if any required label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county Bulletins.

b. Ecological Effects Data

The ecotoxicological data base is adequate to characterize the toxicity of fenamiphos to nontarget terrestrial and aquatic organisms when used on terrestrial food and nonfood sites.

(1) Terrestrial Animal Data

In order to establish the toxicity of fenamiphos to birds, the following tests are

required using the technical grade material: one avian single-dose oral (LD_{50}) study on one species, preferably the mallard or bobwhite quail; two subacute dietary studies (LC_{50}) on one species of waterfowl (preferably the mallard duck) and one species of upland game bird, preferably bobwhite quail or ring-necked pheasant).

Wild mammal testing is required on a case-by-case basis, depending on the results of the lower tier studies such as acute and subacute testing, intended use pattern, and pertinent environmental fate characteristics.

A honey bee acute contact LD_{50} study was required because the proposed uses of fenamiphos could result in honey bee exposure.

(a) Avian Acute Toxicity

Avian Acute Oral Toxicity Findings			
Species	**% Test Material (TGAI)**	**LD_{50}**	**Conclusions**
Bobwhite quail	90 %	1.6 mg/kg	very highly toxic

Data show that fenamiphos is very highly toxic to birds. Data also indicate that a Level of Concern has been exceeded for both endangered and nonendangered avian species. The guideline requirement for the avian acute oral LD_{50} study is fulfilled. (MRID # 0012189)

Incident data support teh conclusion that fenamiphos is very highly toxic to birds. Treatment-related avian mortalities were documented at six different golf courses when Nemacur 3 was applied to control mole crickets. In addition, 23 birds showed symptoms of behavioral impairment. While conducting a bird census study, several instances of mortality and/or behavioral deficits were observed when Nemacur 10 G was applied according to label directions on golf courses. The application of Nemacur 15 G to Florida citrus groves resulted in depressed plasma cholinesterase levels in nearly one third of the avian local species for approximately 30 days post-treatment. (MRID #s 42029902, 2029901, and 41012902)

(b) Avian Subacute Dietary Toxicity

Avian Subacute Dietary Toxicity Findings			
Species	**% Test Material**	**LC_{50}**	**Conclusions**
Bobwhite Quail	88 %	38 ppm	very highly toxic
Mallard Duck	88 %	316 ppm	highly toxic

On a subacute dietary basis, fenamiphos is very highly toxic to birds. Two studies, one on the mallard duck and one on the bobwhite quail, produced LC_{50} values of less than 317 ppm. The above studies indicate a potential "may affect" for endangered avian species via dietary exposure. The guideline requirement is fulfilled. (MRID #s 00025959, 00025958)

(c) Avian Reproduction

Avian reproduction was required because avian species will be continuously exposed to fenamiphos due to its relative persistence in the environment.

Avian Reproduction Findings			
Species	**% A.I.**	**Reproductive Impairment**	**Conclusions**
Bobwhite Quail	90 %	MATC = 5 ppm	may affect avian reproduction at dietary residues as low as 5 ppm
Mallard Duck	90 %	MATC = 12 ppm	

Fenamiphos may affect avian reproduction as low as 5 ppm. From the results of two studies, the "no observed effect levels" (NOEL) for the bobwhite quail and the mallard duck were determined to be 2 ppm and 8 ppm, respectively. Similarly, the "lowest observed effect levels" (LOELs) were determined to be 8 ppm and 16 ppm, respectively. The "maximum allowable toxic concentration" (MATC), which is the arithmetic mean between the NOEL and the LOEL, was determined to be 5 ppm for the bobwhite quail and 12 ppm for the mallard duck. (MRID #s 00121291, 00121290)

(d) Toxicity to Nontarget Mammals

Mammalian Acute Oral Toxicity Findings		
Species	**LD_{50}(mg/kg)**	**Conclusion**
Rat	2.38	very highly toxic

The available mammalian data indicate that fenamiphos is very highly toxic to small mammals on an acute basis. These results also indicate that a Level of Concern has been exceeded for both endangered and nonendangered mammalian species. The results of the above studies indicate a potential may affect for endangered mammalian species from the acute route of exposure.

(e) Nontarget Insect Toxicity

Honey bee acute contact study is required if the proposed use will result in honey bee exposure.

Nontarget Insect Acute Contact Toxicity Findings		
Species	**LD_{50}(mg/kg)**	**Conclusion**
Apis mellifera	1.87 ug/bee	highly toxic

Fenamiphos is highly toxic to the honey bee based on the acute contact LD_{50} value that was determined to be 1.87 micrograms per bee. (MRID # 00036935)

(2) Aquatic Animal Data

(a) Freshwater Fish Toxicity

In order to establish the toxicity of a pesticide to freshwater fish, the minimum data required on the technical grade of the active ingredient are two freshwater fish toxicity studies. One study should use a coldwater species (preferably the rainbow trout), and the other should use a warmwater species (preferably the bluegill sunfish).

Freshwater Fish Acute Toxicity Findings			
Species	**% Test Material (TGAI)**	**LC_{50}**	**Conclusions**
Rainbow trout	81 % tech 15 % G 30 % TEP	71 ppb 563 ppb 68 ppb	very highly toxic to freshwater species
Bluegill sunfish	88 % tech 81 % tech	9.6 ppb 17.7 ppb	very highly toxic to marine species
Sheepshead minnow	88.7 % tech	17 ppb	very highly toxic to freshwater species

The results of the 96-hour acute toxicity studies indicate that fenamiphos is very highly toxic to both cold and warmwater fish. The guideline requirements for acute toxicity testing of the technical on freshwater and marine fish have been satisfied. (MRID #s 00025962, 00114012, 00114012, 40799704, 00114012, 00114012, and 40799701)

Early life and mesocosm studies showed that fenamiphos is very highly toxic to freshwater fish. The early life-stage MATC value of technical fenamiphos for the rainbow trout is greater than 3.8 ppb but less than 7.4 ppb. Results of a mesocosm study with the Nemacur 3 TEP showed adverse effects occurred at levels greater than 3.5 ppb. (MRID #s 41064301 and 42029906)

(b) Freshwater Invertebrate Toxicity

The minimum testing required to assess the hazard of a pesticide is a freshwater aquatic invertebrate toxicity test, preferably using first instar *Daphnia magna* or early instar amphipods, stoneflies, mayflies, or midges.

Freshwater Invertebrate Toxicity Findings			
Species	**% Test Material (TGAI)**	**LC_{50}**	**Conclusions**
Daphnia magna	88 % tech sulfoxide TEP	1.9 ppb 7.5 ppb 1.3 ppb	very highly toxic

There is sufficient information to characterize fenamiphos as very highly toxic to aquatic invertebrates. The guideline requirement is satisfied. (MRID #s 40799706, 41497701, and 43183501)

(c) Estuarine/Marine Toxicity

Acute toxicity testing with estuarine and marine organisms is required when an end-use product is intended for direct application to the marine/estuarine environment or is expected to reach this environment in significant concentrations. Because fenamiphos is of potential concern to surface water contamination, use of fenamiphos may result in exposure to the estuarine environment.

The requirements under this category include a 96-hour LC_{50} for an estuarine fish, a 96-hour LC_{50} for shrimp, and either a 48-hour embryo-larvae study or a 96-hour shell deposition study with oysters.

Estuarine/Marine Acute Toxicity Findings			
Species	**% Test Material (TGAI)**	**LC_{50}**	**Conclusions**
Eastern oyster embryo larvae	88 %	1.65 ppm	moderately toxic
Pink Shrimp	88 %	6.2 ppb	very highly toxic

There is sufficient information to characterize fenamiphos as moderately toxic to the eastern oyster and very highly toxic to the pink shrimp. The guideline requirement has been satisfied. (MRID #s 40799709 and 40799708)

(3) Terrestrial, Semi-Aquatic and Aquatic Plant Data

Terrestrial plant testing (seed germination, seedling emergence and vegetative vigor) and aquatic plant testing are required for herbicides which have terrestrial nonfood/feed or aquatic nonfood (except residential) use patterns and which have endangered or threatened plant species associated with the site of application. They are only required for pesticides when incidents of adverse effects to plant species are reported to the Agency. No incidents have been reported for fenamiphos, therefore these studies were not required.

ENDANGERED SPECIES FOR FENAMIPHOS

AQUATIC SPECIES	TERRESTRIAL SPECIES
Toad, Wyoming Cavefish, Alabama Dace, blackside Darter, amber Darter, bayou Darter, boulder Darter, Maryland Darter, slackwater Darter, snail Logperch, Conasauga Madtom, yellowfin Minnow, loach Pupfish, desert Shiner, Cape Fear Silverside, Waccamaw Sucker, Lost River Sucker, Modoc Sucker, shortnose Sucker, Warner Mussel, Curtis' Mussel, Judge Tait's Mussel, Marshall's Mussel, penitent Pearlshell, Louisiana Pearly mussel, Alabama lamp Pearly mussel, Applachian monkeyface Pearly mussel, birdwing Pearly mussel, Cumberland bean Pearly mussel, Cumberland monkey face Pearly mussel, dromedary Pearly mussel, green-blossom Pearly mussel, little-wing Pearly mussel, pale liliput Pearly mussel, turgid blossom Pearly mussel, white wartyback Pigtoe, fine-rayed Pigtoe, rough Pigtoe, shiny Riffle shell, tan Spinymussel, Tar River Stirrup shell Crayfish, Nashville Shrimp, Kentucky care	Falcon, northern aplomado Plover, piping Stork, wood Vireo, least Bell's